SPECIAL ARTICLES

ALTAMAHA FORMATION OF THE COASTAL PLAIN OF GEORGIA[1]

THE name, Altamaha, was applied by Dr. W. H. Dall[2] in 1892 to a sandstone and gritty clay formation prominently exposed along the Altamaha and Ocmulgee Rivers of Georgia. The study of the formation was confined mainly to the above-mentioned rivers. Mr. R. M. Harper[3] later studied the formation in some detail from a phytogeographical standpoint. The age of the Altamaha and its relation to other formations of the coastal plain, however, have been unsettled. The writer has spent considerable time during the past summer in studying and mapping the formation and presents some conclusions concerning it.

The Altamaha is the most widespread formation of the coastal plain of Georgia, covering approximately 21,000 square miles or three fifths of the entire coastal plain of Georgia. Occurrences have been noted to within a few miles of the Atlantic coast. Good exposures of red sand and clay are found near Savannah, Waynesville, Brunswick and Kingsland, while the probabilities are that it occurs on the sea islands. It thence extends northward into Burke County to within twenty miles of Augusta on the Fall Line. Thence going in a southwestward course its northward extent is marked by the towns of Tennille, Dublin, Hawkinsville and Vienna to Flint River. West of Flint River no formation has been identified with certainty as the Altamaha, except in Decatur County, in the extreme southwestern part of the state. Southward it extends into Florida.

As a whole the Altamaha consists of yellow and red sand and both massive and stratified layers of gritty clay, with local areas of indurated grit or sandstone and clay. The surface aspect, which is peculiarly characteristic throughout the terrane, is a mottled or "calico" effect; that is, the weathered surface is a splotched red, yellow and white and very frequently purplish and white, due to unequal weathering and oxidation of iron minerals. At some localities small brown iron oxide accretions from the size of buckshot to walnuts are abundant at the surface, and the land where these are found is commonly referred to as "pimple" land. These iron oxide pebbles are products of weathering of the Altamaha clay-sand and are almost certain evidence, where found, that the underlying formation is the Altamaha. The topography of the Altamaha formation is rolling and unlike that of any other coastal-plain formation.

The sand of the formation is usually a coarse quartz sand, red and yellow or orange in color, and occasionally has a brownish tint. It is always more or less argillaceous and contains, frequently, layers of small quartz pebbles. A characteristic of these pebbles is their angularity, some being lath-shaped, showing scarcely any rounding of the angles. The pebbly feature is nowhere very prominent and is exceptional rather than general. In a few localities, the pebbles are rather large, attaining a diameter of four or five inches. Near the Atlantic coast and in the southwestern part of the state the sand may be fine grained, rarely micaceous, cross-bedded, and interstratified with thin layers and leaves of plastic clays. These clay layers may not exceed an inch in thickness. Such structure is seen in the exposures of the Altamaha near Jesup and Waynesville in Wayne County and near Whigham in Grady County.

The clay of the Altamaha is fairly uniform in texture and composition throughout the Altamaha area. It is a greenish or drab, very fine-grained and highly plastic and always more or less sandy. It has a low specific gravity and absorbs a high percentage of water. It often has an acid or sour taste, due, likely, to aluminum sulphates. It occurs in thick irregular pockets or thin lenticular layers or leaves, never persisting as in individual beds over any large area. A tolerably characteristic appearance throughout is greenish clay, full of coarse angular quartz particles and subangular decomposed feldspar pebbles. The clays may be locally indurated, the ce-

[1] Published by permission of the state geologist of Georgia.

[2] Bull. No. 84 U. S. G. S.

[3] *Annals N. Y. Acad. Sci.*, Vol. XVII., Pt. I.

menting material being opaline silica. As above mentioned, the clays are generally green and drab, but in the vicinity of Thomasville there are white clays containing as little as two per cent. of iron oxide.

The grit or sandstone feature of the Altamaha, the feature which is most striking and which was first studied, is typically exposed along the Altamaha River. It consists of gray or greenish aluminous sandstone more or less mottled and stained by iron oxide. In restricted localities pebbles are imbedded in the sand and clay matrix, and cemented into a conglomerate; but, except for the pebbles, these beds do not appear different from the typical Altamaha sandstone. The percentage of clay in the indurated rock varies from five to ten per cent. to such a high percentage that the rock is an indurated clay rather than a sandstone. The cementing material is an opaline silica and the rock may be extremely hard and even glassy and quartzitic in appearance, but is generally, however, soft and friable. The rock is strikingly similar in its lithological aspect throughout widely separated areas and is easily identified, although it is entirely devoid of any fossils. Except along the Altamaha River, only widely separated outcrops occur. It never presents any great thickness, jutting beds fifteen or twenty feet thick being exposed over a few acres. Exposures of grit are common throughout the northern part of the Altamaha region, but are not observed near the coast nor the Florida boundary line. It is believed that these isolated exposures are local indurations only and not parts of a continuous sandstone bed.

While in the foregoing the sand, clay and sandstone are described separately, they do not form stratigraphical units. Sand, clay and sandstone may be seen in the same vertical section, in which the clay may be replaced by sand, and sand and gritty clay may be seen gradually changed from non-indurated to indurated rock, from soft sand and clay to typical Altamaha grit.

The thickness of the formation can be ascertained only from data from deep well borings. The Altamaha in Georgia attains a known thickness of 350 feet and probably reaches 500 feet. From this maximum thickness, which occurs in the counties of Emanuel, Tatnall, Toombs, Coffee and Tift, it is attenuated both northward and southward. The thickness in the southwest part of the state can hardly be more than 200 feet as a maximum, and on the Atlantic coast probably does not exceed 100 feet. As a whole, the study shows evidence of a rapid deposition in a shallow basin-like sea. There is a notable absence of any calcareous layers or nodules, chemical analyses, even of both the clays and the sandstone, showing only a trace of lime or none at all. The material composing the Altamaha was largely derived from the metamorphic and igneous rocks of the Piedmont region.

The Altamaha has been observed overlapping and overlying Eocene, Lower Oligocene, Upper Oligocene, Miocene and questionably Pliocene strata and is to some extent a superficial deposit.

In Burke and Washington counties, in the northeast part of the coastal plain, the Altamaha is observed overlapping red sand and gravel belonging to the Claiborne (Eocene) group. The red sand of the Claiborne contains thin quartzitic layers with Eocene fossils, and can hardly be mistaken for the Altamaha, although the two may in places have similar texture and color.

It overlaps Lower Oligocene rocks (Vicksburg group) in the counties of Pulaski, Dooly and along the east side of Flint River down to Camilla. Near the contact with the Vicksburg group it is frequently found to contain flint fragments, which are evidently derived from the Vicksburg.

At a number of points in Decatur, Grady and Thomas counties, the Altamaha overlies beds of Upper Oligocene age, seemingly without unconformity. On the Monticello road, four miles southwest of Boston, red and brown sands of the Altamaha pass by a gradual transition into clay and sand containing fragments of oysters and the coral, *siderastrea*, which identify the beds as Upper Oligocene. This might be taken as evidence of identity

of beds, but more probably the deposition of the Altamaha resulted in the intermixing of beds of similar material, thus obliterating any sharp line of contact between the two, and the apparent continuity of deposition may be thus accounted for. Likewise, at Attapulgus, in Decatur County, red sands and green clay overlie without noticeable unconformity a fuller's-earth deposit, which is regarded as being the equivalent[4] of the Alum Bluff beds.

An excellent vertical section, showing the relation of the Altamaha to Miocene strata, is exposed in the bluff of the Altamaha River at Doctortown, where thirty feet of stratified Altamaha clay and sand overlie a fossiliferous bed containing Miocene pectens. The fossiliferous bed here is four feet thick and is composed of bluish-gray sand full of large pectens and a calcareous sandy layer one foot thick, full of small bivalves and comminuted shells. The section of the bluff is:

	Feet
1. Yellow and mottled argillaceous sand	10
2. White and yellow cross bedded sand containing thin layers of small pebbles	10
3. Red and yellow stratified sand, containing thin clay laminæ or leaves	10
4. Calcareous fossil sand	1
5. Bluish sand, containing pectens	3
6. Bluish sand clay	7

No. 1 of this section has the typical mottling of the Altamaha sand and brown iron oxide accretions are found at the surface as elsewhere over the Altamaha region. The above section is of considerable interest because of the light that it throws on the age of the upper thirty feet of strata. The bluff is referred to by Dall[5] as being Altamaha grit and is described by McGee[6] as Lafayette. A section identical with the one given above occurs at Linders Bluff, three miles above Doctortown, and similar sections are found in the bluffs of the Altamaha River several miles below Doctortown—the upper and lower Sancivilla bluffs. No fossils, however, were observed at the Sancivilla bluffs, except bits of lignitized plant remains.

[4] T. W. Vaughan, Bull. No. 213, p. 392.
[5] Bull. No. 84, U. S. G. S.
[6] U. S. G. S., 12th Ann., Pt. I., p. 484.

The Altamaha has not been identified with certainty lying in contact with strata bearing Pliocene fauna, but there is strong probability that it does overlie such strata. A marl bed overlain by clayey sand outcrops on the Satilla River six miles below Atkinson, from which fossils were collected by Mr. S. W. McCallie and identified by Mr. T. H. Aldrich, as being Pliocene. The Altamaha is exposed at Waynesville, a few miles east of Atkinson, and undoubtedly overlies the above-mentioned marl beds on the Satilla River. Also, marine shells and vertebrate remains brought up by recent dredgings at Brunswick further suggest the probability of Pliocene fossil beds near the coast.

Overlying the Altamaha formation unconformably there is everywhere a thin mantle or superficial layer of loose sand of Pleistocene age. This sand is a light gray or brown in color, shows no stratification, is free from clay, and is always easily distinguished from the Altamaha. It varies in thickness from 0 to 50 or 60 feet, and the average thickness is not more than 10 feet. This sand presents a remarkable uniformity in color and texture throughout the whole coastal plain, from the sand hills of the fall line to the Atlantic coast.

Summing up the known facts concerning the Altamaha formation, the writer is inclined to regard it as being late Pliocene in age. The formation itself contains no fossil evidence which will aid in determining its position, being devoid of all fossil remains except a few bits of wood; and the conclusion concerning its age is reached from the knowledge that it overlies Miocene and Pliocene strata and is older than the coastal Columbia sand, which is of Pleistocene age. The correlation of the numerous exposures of the Altamaha has been determined by stratigraphical continuity, homogeneity and physiographic features. Beginning with an outcrop of typical Altamaha in the northern part of the Altamaha region, it was traced by examination of exposures at short intervals to the Atlantic coast and to Florida. In Georgia, at least, it is believed that it is identical with the formation which McGee considered Lafayette. In his study of the Lafayette in Georgia, in the Twelfth An-

nual Report of the U. S. Geological Survey, references are made to Millen, Green's Cut, Waycross and Doctortown as being localities where the Lafayette might be seen. The beds at the localities mentioned can undoubtedly be correlated with the Altamaha.

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CURRENT NOTES ON METEOROLOGY AND CLIMATOLOGY

LIGHTNING VAGARIES

In the *Quarterly Journal of the Royal Meteorological Society* for October, 1907, there is an account, given by Professor A. Herschel, of a remarkable excavation made by lightning in peat earth in a moorland district of Northumberland. A large hole, four or five feet in diameter, was found on a flat part of the moor, radiating from which there were six or seven furrows, and pieces of turf were thrown in various directions. The largest turf, about three feet in diameter and one foot thick, was lying 26 yards away, and other pieces were lying around within 20 yards of the hole. On excavating the hole it was found that a number of small holes radiated to various depths. Col. J. E. Capper gives an account of a captive balloon being struck by lightning.

CLOUD CLASSIFICATION

Professor Willis I. Milham, of Williams College, has published a useful pamphlet on *Cloud Classification,* intended for the use of his students in meteorology, as a guide in their practical work on cloud classification and origin (8vo, pp. 9). This pamphlet considers very briefly (1) the early history, (2) the international system, (3) the causes of clouds and (4) the thirteen cloud forms. The discrepancy between the usual ten forms of the International Classification and the thirteen here referred to comes from the fact that Professor Milham counts fracto-stratus, fracto-cumulus and fracto-nimbus each as one form. Together with the description of the individual types, reference is made to the methods of formation.

METEOROLOGICAL FORMULÆ AND TABLES

Professor Paul Schreiber, director of the Meteorological Service of Saxony, publishes a series of "Formeln und Tabellen" as a *Vorarbeit* to his Annual Report for 1903 (Dresden, 1907, fol.). These formulæ and tables deal chiefly with the thermodynamics of the atmosphere, and are designed for practical use in meteorology. The formulæ are given at the beginning. A discussion on their use follows, and a series of diagrams at the end illustrates the various physical conditions and processes concerned.

A "STEP" ANEMOMETER

At a recent meeting of the Royal Meteorological Society (*Quart. Journ. Roy. Met. Soc.,* October, 1907) Mr. Walter Child exhibited and described his "step" anemometer, which he has designed to obviate the "sheltering error." This instrument is a Robinson anemometer, with the cups so placed on the spindle that the arms are in different horizontal planes. Thus one cup does not shelter another, and the system comes to rest more rapidly when the wind drops.

R. DeC. Ward

THE MEETING OF THE INTERNATIONAL SEISMOLOGICAL ASSOCIATION

The first general assembly of the International Seismological Association since its formal inauguration in 1905, and the second meeting of its permanent commission, were held at the Hague from September 21–26, last.

Twenty-two states are now members of the association, England, Austria and Canada having joined since last year. Although France has not formally joined, preliminary steps have been taken for this purpose and it is hoped that she will soon be a regular member. Chile, the Congo, Norway, Portugal and Roumania are the only countries, members of the association, which were not represented at the meeting. There were about fifty persons present either as delegates or as invited guests, and this included a majority of the leading seismologists of the world. Professor van der Stok and his assistants made all the arrange-